



GROUNDWATER MONITORING

Bob Barnwell, PG ADEM Hydrogeologist

ADEM LAND DIVISION

www.adem.alabama.gov

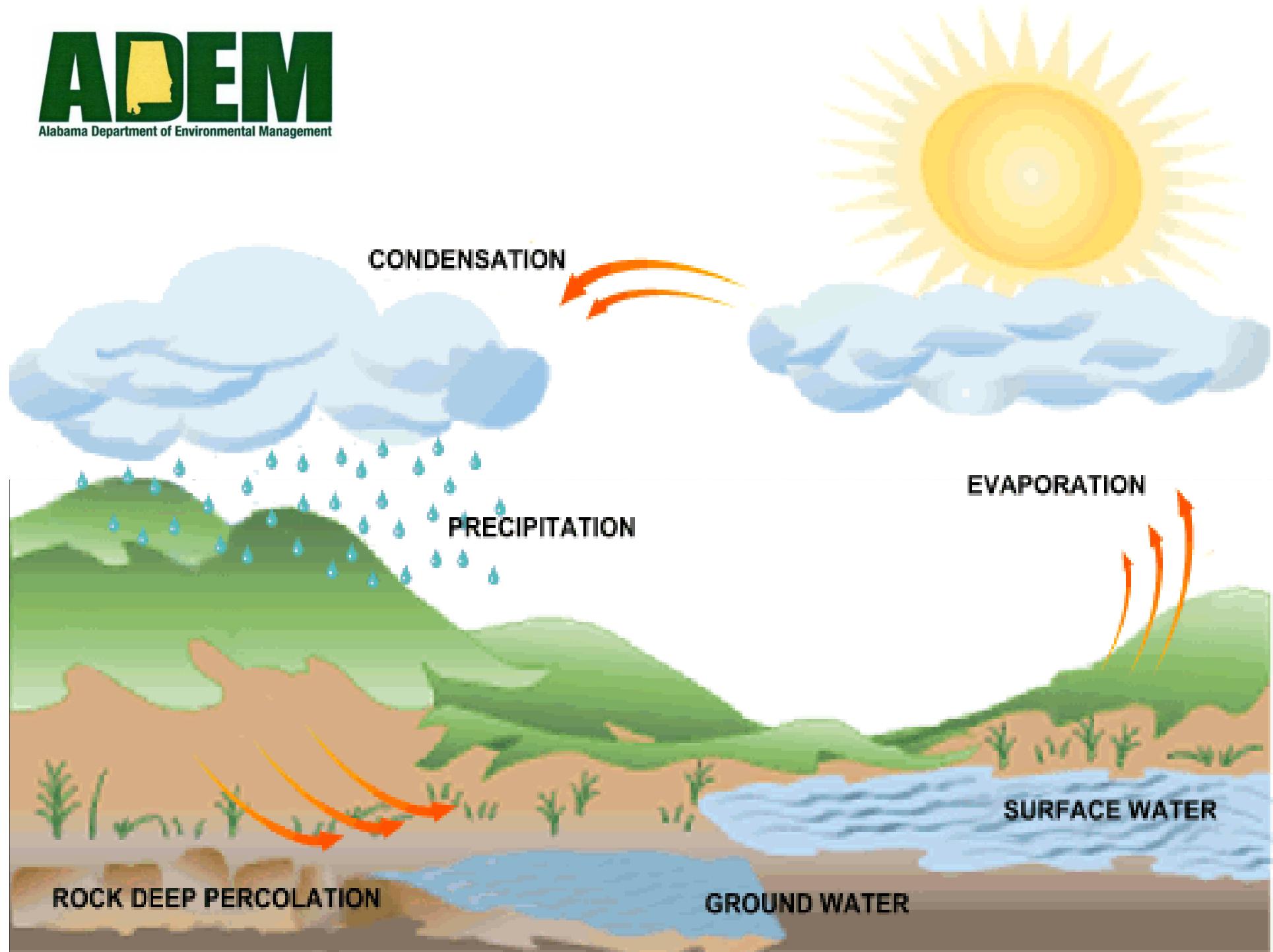


*Mission: Assure for all
citizens of the state a safe,
healthful and productive
environment.*



Groundwater

- ▶ Safe Drinking Water Act
- ▶ ADEM Division 6 and 14
- ▶ Alabama Water Pollution Control Act
- ▶ Alabama Water Resources Act
- ▶ AL Water Resources Management Policy
- ▶ Municipal groundwater restrictions

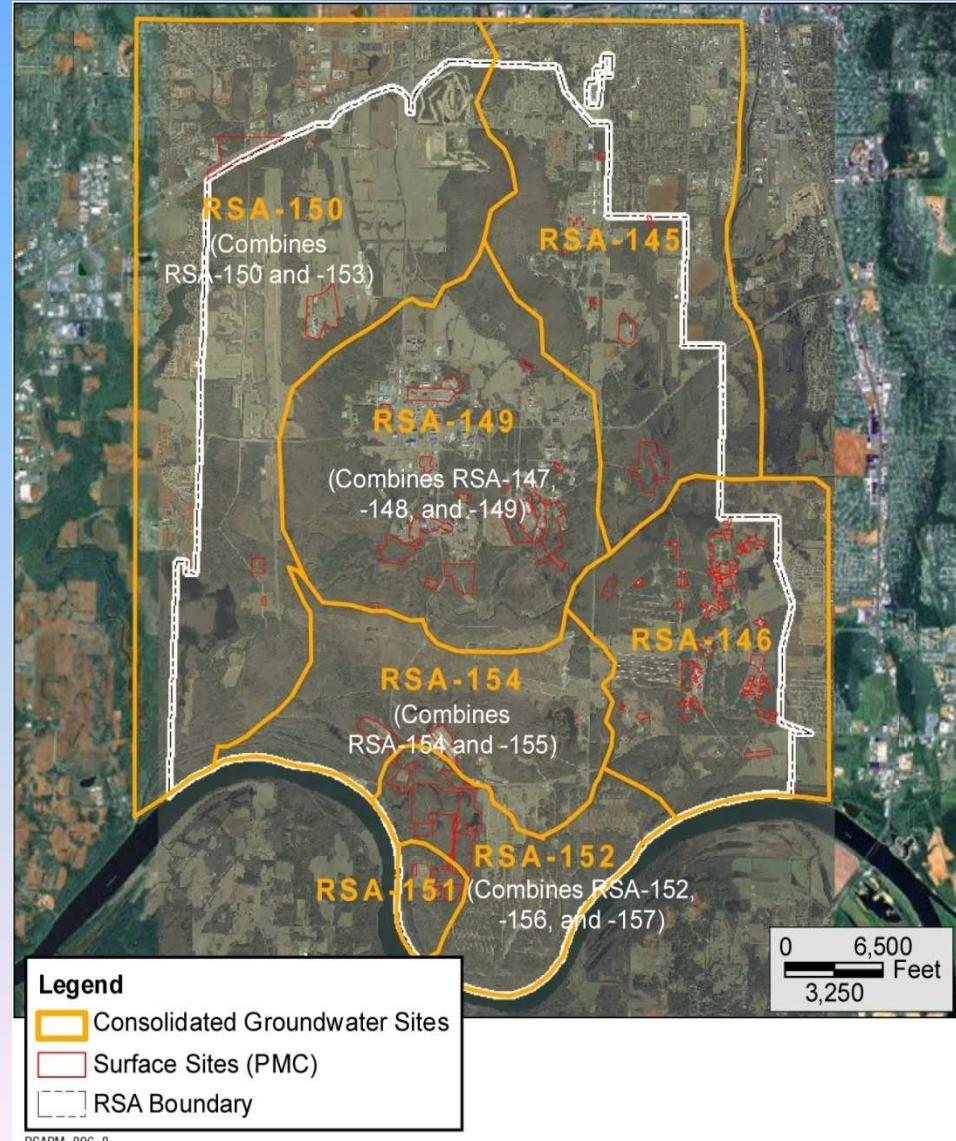


Redstone Arsenal



Rosie the Riveter

2015





- **1941** Redstone
 - Huntsville Arsenal
 - Gulf Chemical Warfare Depot
 - Redstone Ordnance Plant
- **Post WW II** rocket production
- **1960** NASA MSFC
- DDT (AL NPL - 1983)
- **Current** Army & NASA (FBI – ATF)



- Permitted since the 1980s
- Redstone on the NPL in 1994
- CERCLA Program until 2010
- Currently all sites regulated under a RCRA Hazardous Waste Facility Permit



Team Members

Army Garrison

- Management
- Scientists
- USACE
- Contractors

ADEM

- Management
- Project Engineers
- Diligent Hydrogeologists
- Contractors





DSMOA

- Expedite environmental restoration at Redstone
- Better protection of human health and the environment
- SMART Monitoring Objectives



- Chemical Munitions
- Rocket Production
- Petroleum Sites
- DDT Manufacturing
- TCE, perchlorate, arsenic, chlorobenzene, carbon tet, petroleum, and explosives.



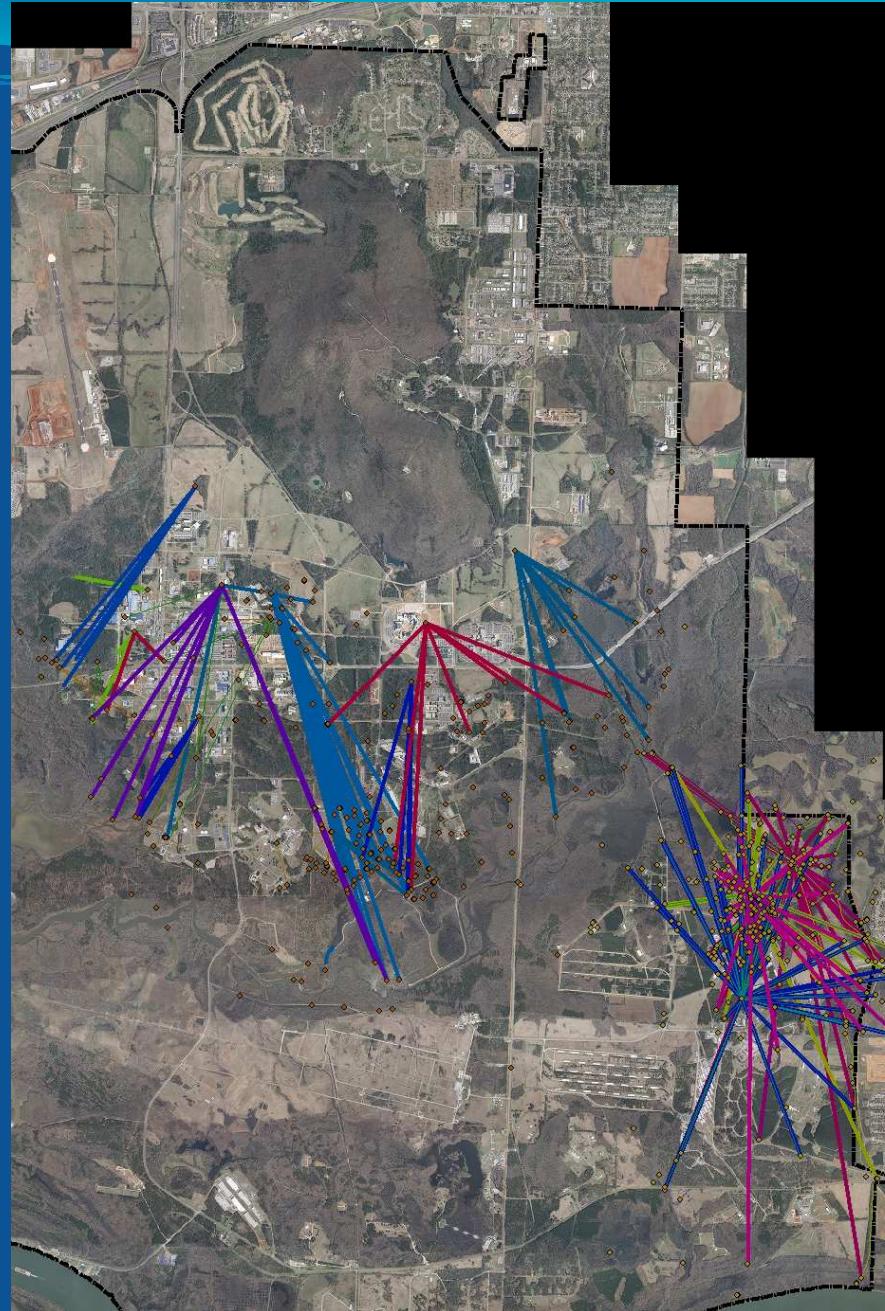
- Surface Media and Groundwater Sites
- Watershed Approach
- LUC on groundwater
- Sitewide Karst Study



Dye Trace

- Redstone and NASA
- Regional by the GSA
- Monitoring to understand flow system

- Discharge at springs
- Detected in shallow and deep wells
- Surface water monitoring



www.adem.alabama.gov

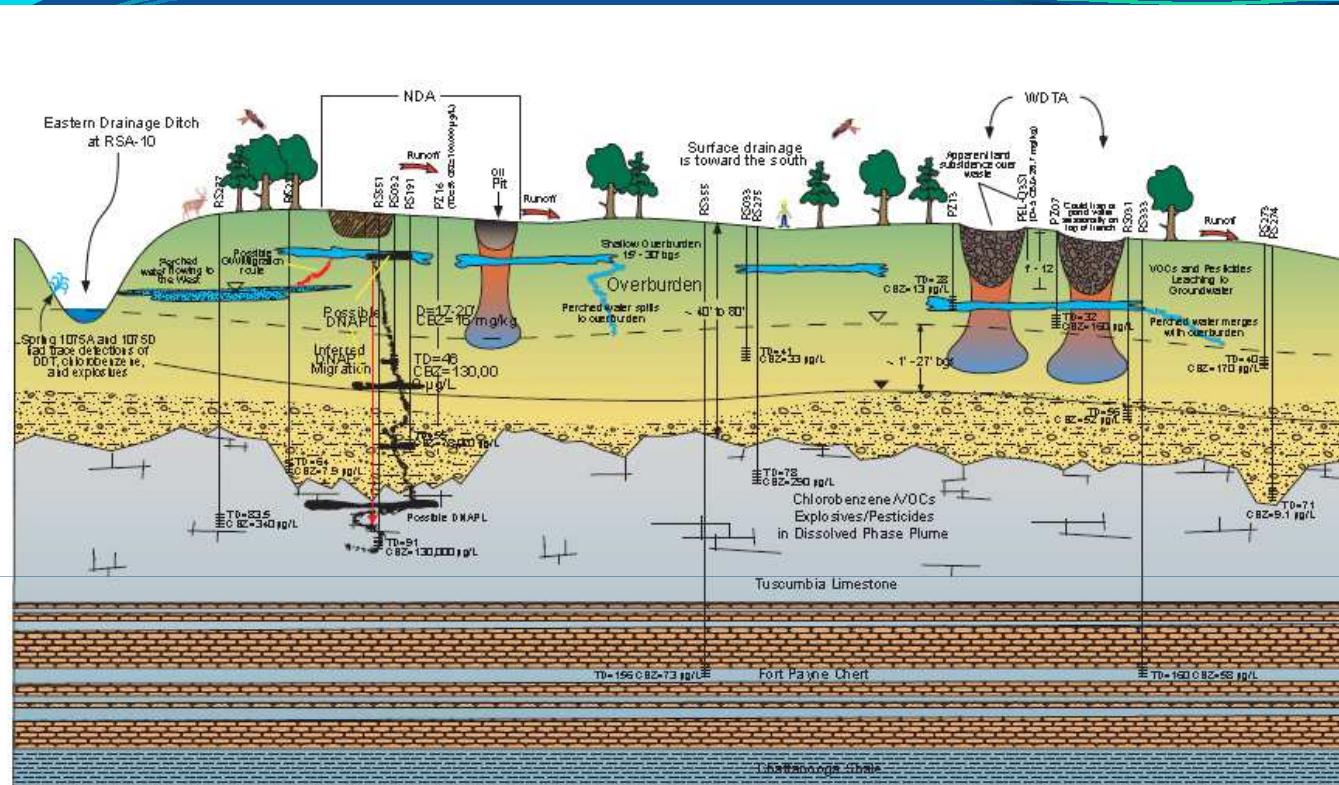


- PSA to RCRA Facility Assessments

- RFI characterization
- Interim measures (GW Monitoring)
- Corrective measures (GW Monitoring)
- Compliance (GW Monitoring)

- ▶ > 4,000 hydropunch and temporary piezometers
- ▶ > 2,700 overburden, interface, and bedrock wells
- ▶ HRSC using MIP in saturated zones.
- ▶ Seismic, geophysics, and hydrogeophysics
- ▶ Clustered or nested wells
- ▶ CMT/FLUTE

Conceptual Site Model



**Not to Scale



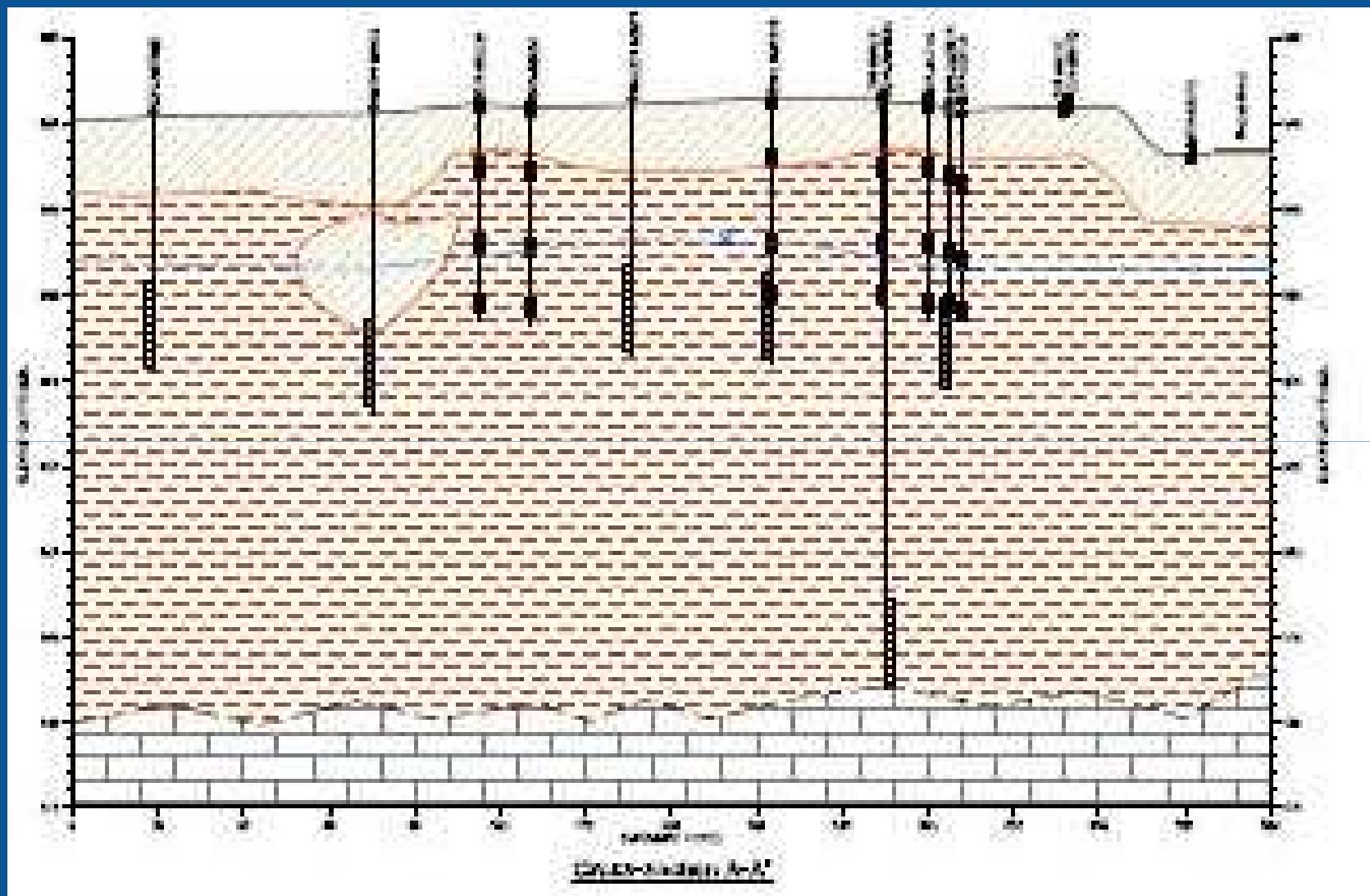
Figure 2-1
RSA-053
Graphical Conceptual Site Model



Residuum Monitoring

- Surface Media Sites
- Perched groundwater
- Hydropunches/Piezometers
- MIP/Slug Tests
- Overburden wells

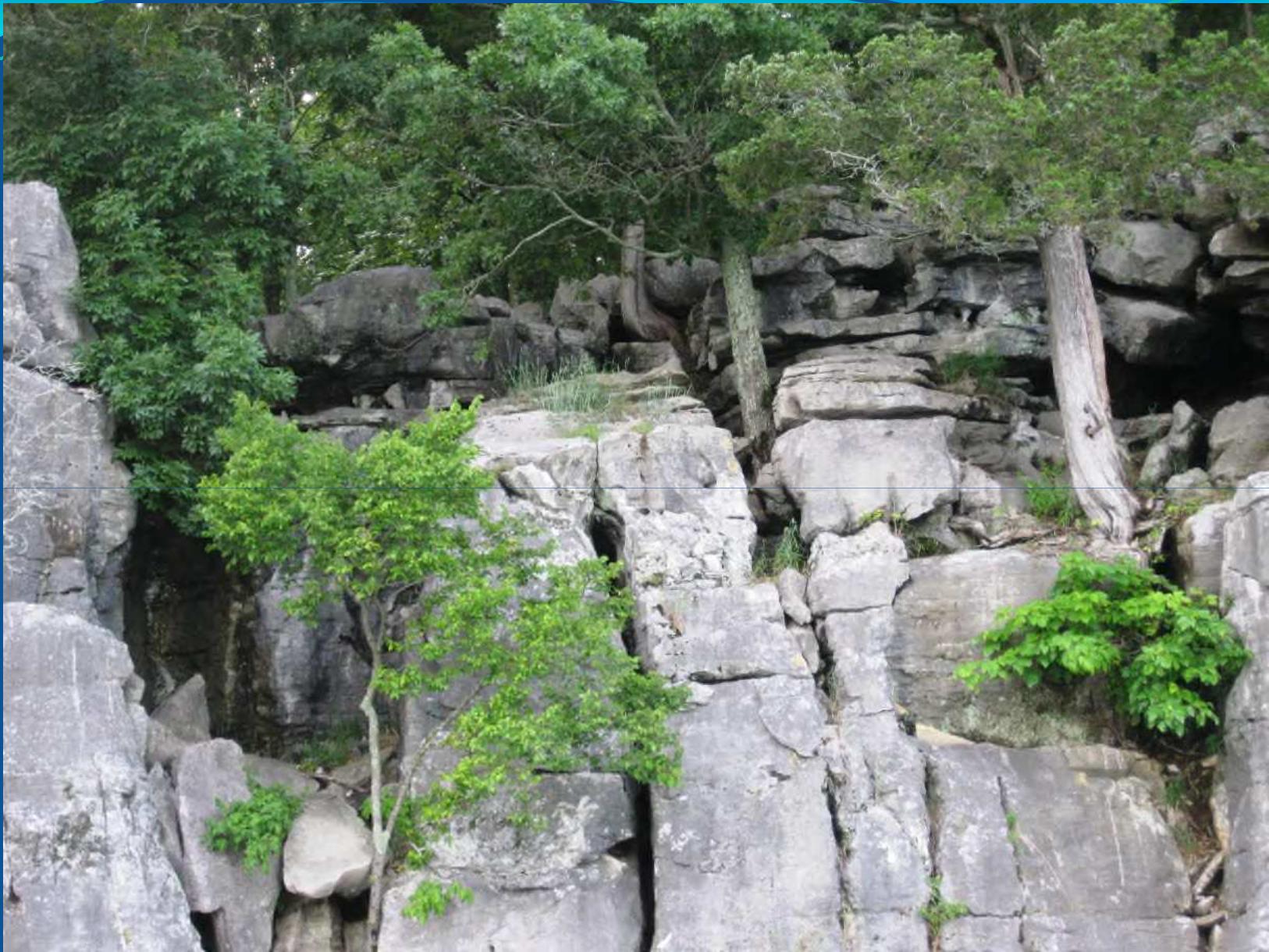


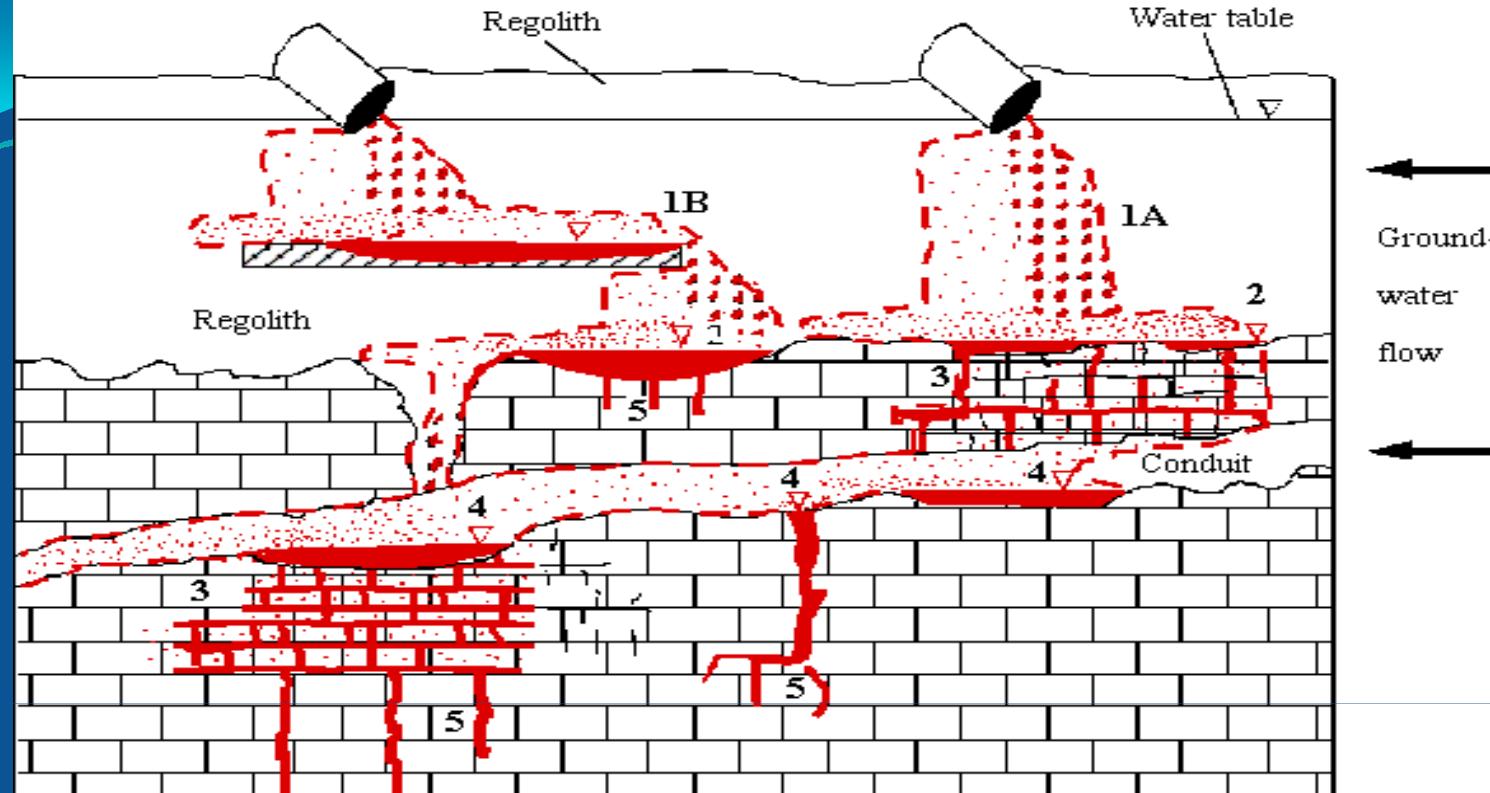




Interface Monitoring

- Surface Media/Groundwater Sites
- Epikarst
- Residuum/bedrock wells





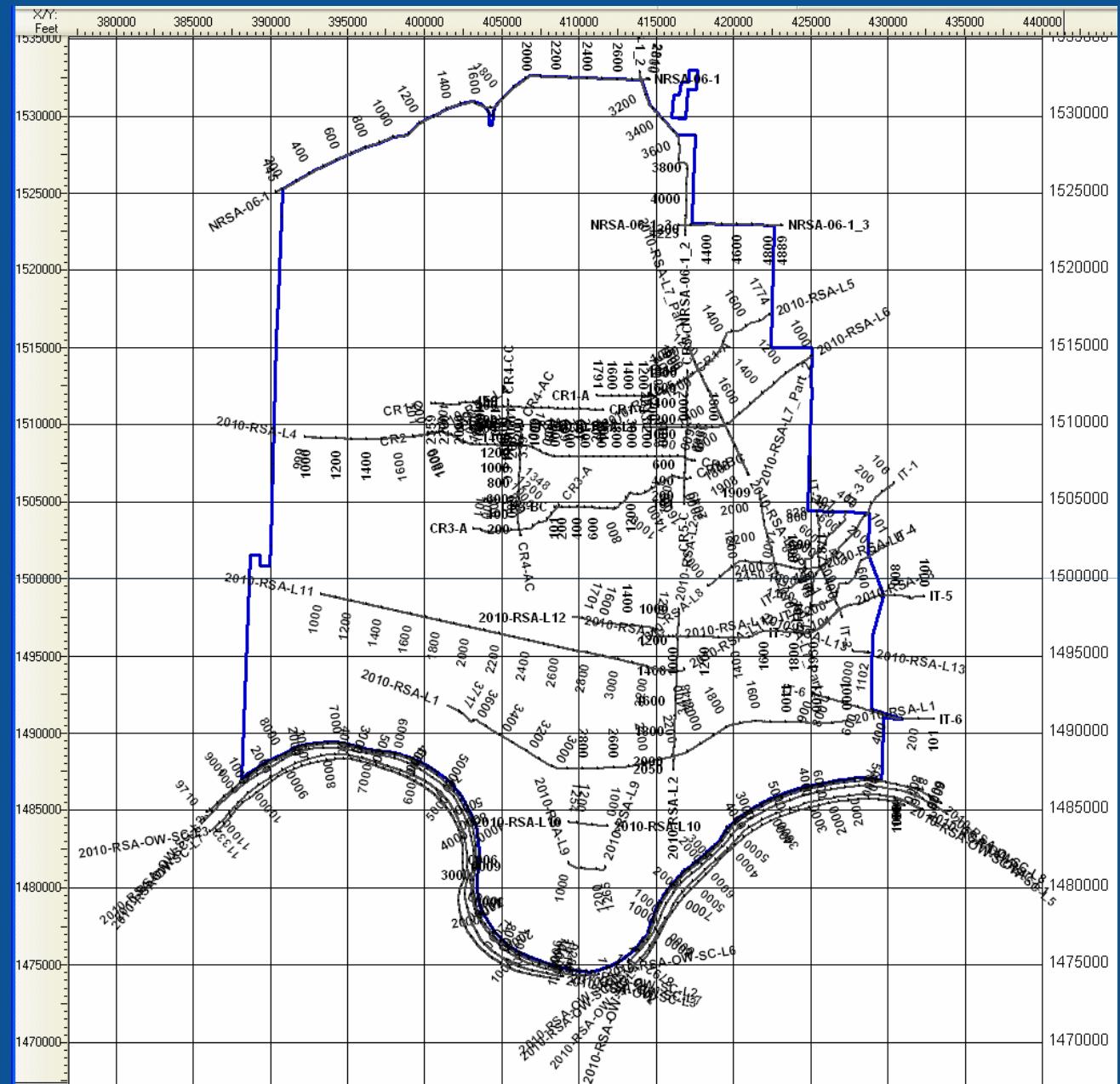
EXPLANATION

- | | |
|--|--|
| 1 TRAPPING IN REGOLITH
1A RESIDUAL DNAPL
1B POOLING ON LOW
PERMEABILITY LAYER | 3 POOLING IN BEDROCK
DIFFUSE-FLOW ZONE |
| 2 POOLING AT TOP OF ROCK | 4 POOLING IN CONDUIT |
| | 5 POOLING IN FRACTURES
ISOLATED FROM FLOW |

- | | |
|-----------------------------|------------------------------------|
| CAVERNOUS CARBONATE
ROCK | LOW PERMEABILITY
REGOLITH LAYER |
| FRACTURED CARBONATE
ROCK | POOLED DNAPL |
| DISSOLVED CONTAMINANT | RESIDUAL DNAPL |

Bedrock Monitoring

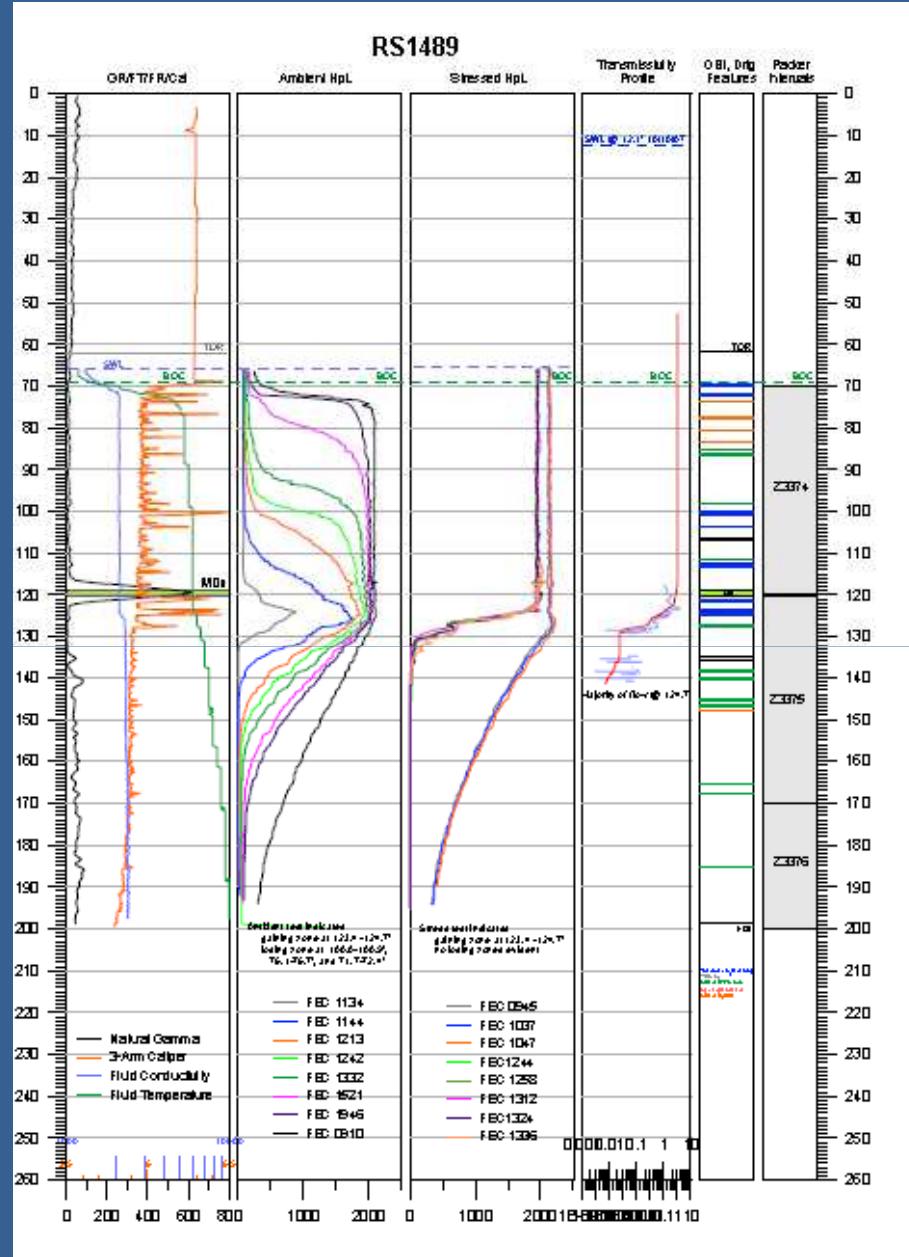
- Groundwater Sites
- Limestone – Limestone
- Shallow groundwater < 120 ‘ bgs
- Deep groundwater > 120 ‘ bgs
- Shale



- Sonic Rig
- Air Rotary
- Liner



- Hydrophysics
- Geophysics





Geophysical Summary Plot

COMPANY: Shaw Environmental

PROJECT: Redstone Arsenal

DATE LOGGED: 30 August, 2007

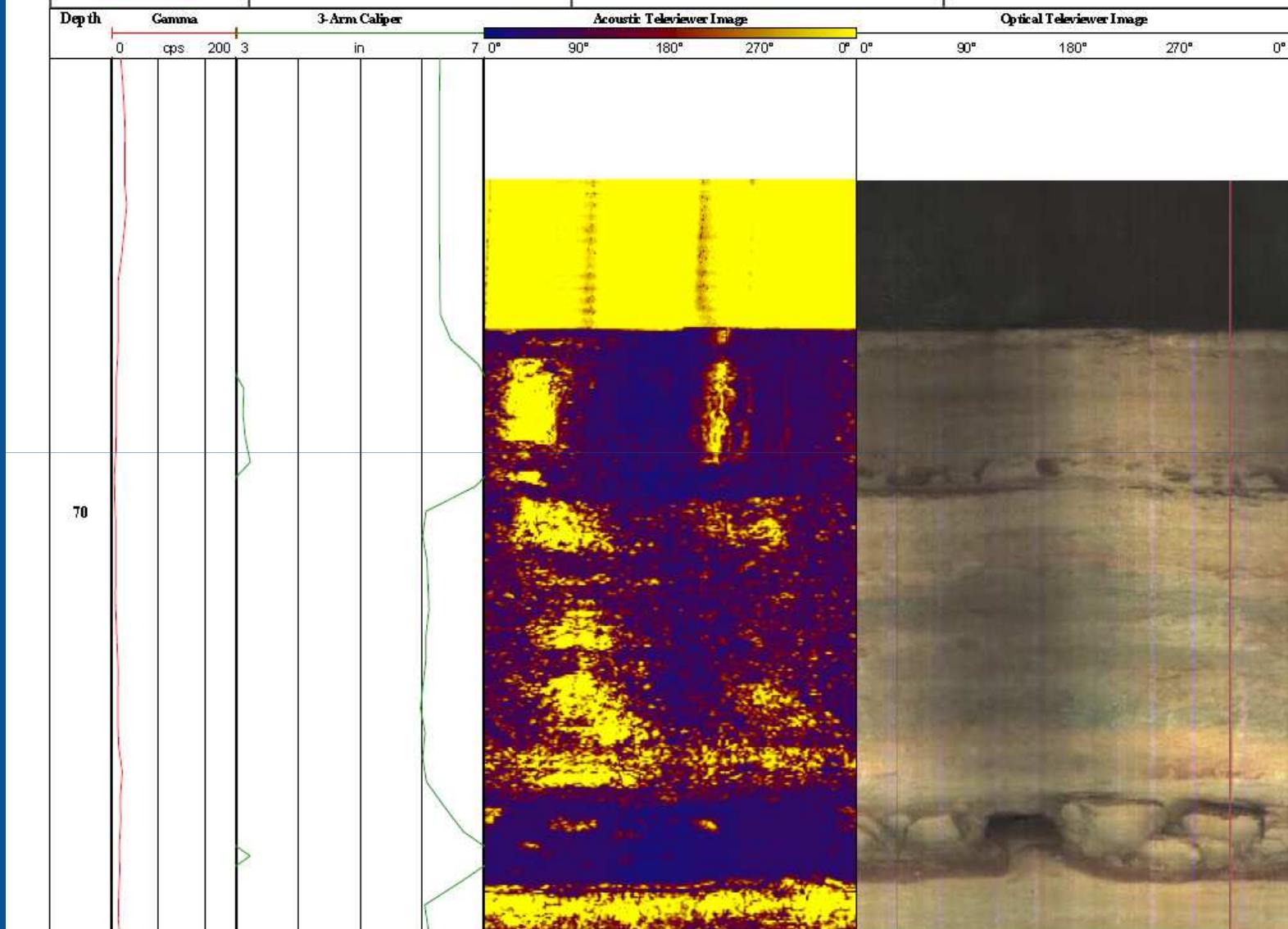
WELL: RS-1489

COLOG Main Office

810 Quail Street, Suite E, Lakewood, CO 80215

Phone: (303) 279-0171, Fax: (303) 278-0135

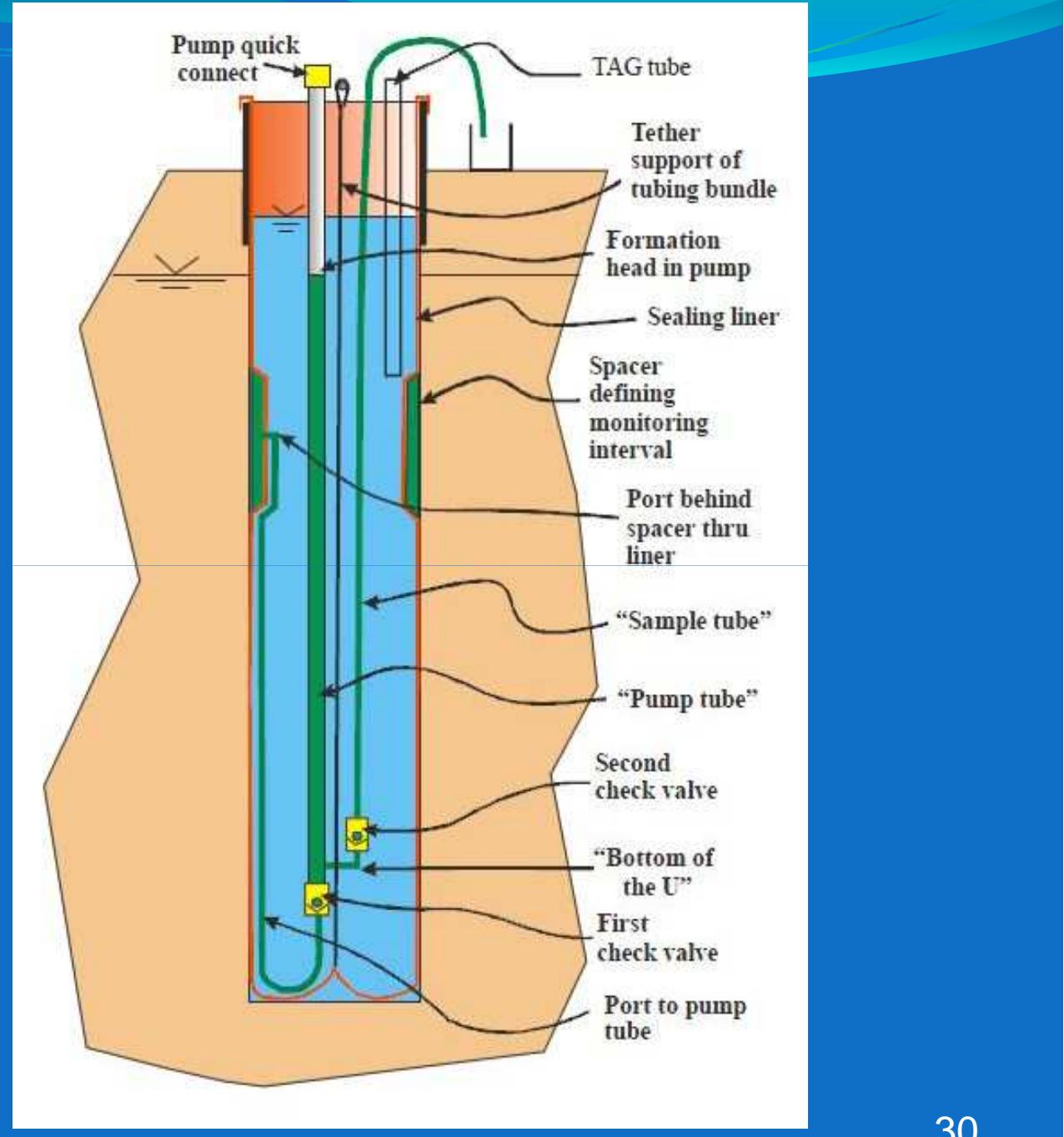
E-mail: colog@colog.com



- 5-Port
FLUTE
Well



- 1-Port FLUTE Well







Permit Groundwater Monitoring Programs

- Detection
- Interim Measures
- Compliance
- Corrective action



Interim Measures

- RSA-095, RSA-096, and RSA-142
 - Pump and Treat
 - Thermal Treatment
- RSA-151
 - PRB shallow and amendments deep
- RSA-088/089
 - Excavation



Compliance

- OB/OD Units
 - Historical Activities
 - Current Operations

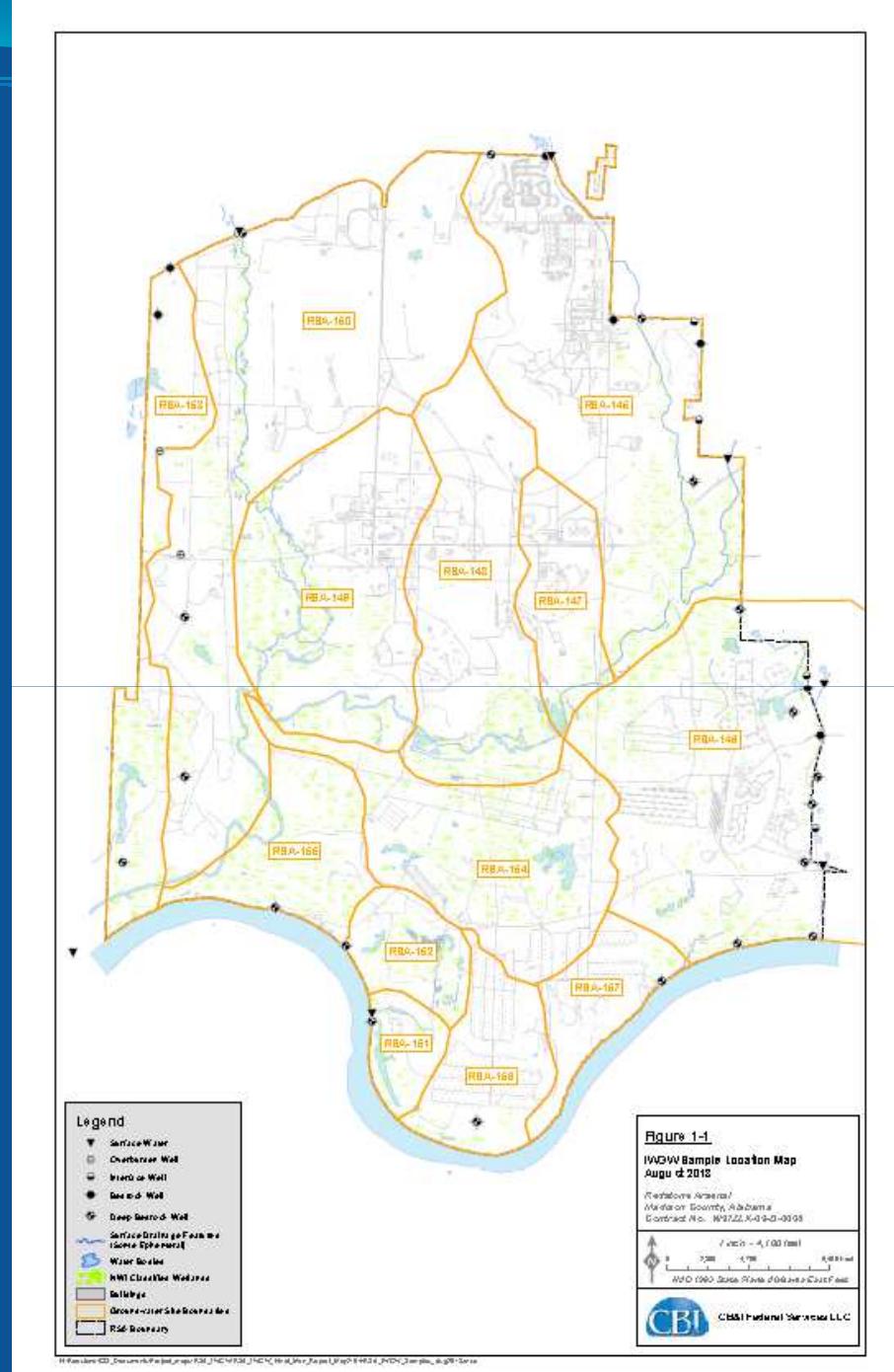


Corrective Action

- RSA-049, RSA-053 and RSA-054/55
 - Capped Landfill
- RSA-057 and RSA-200
 - Excavation
- Installation-Wide GW
 - Will grow!!

IWGM

- 69 Screened Intervals
- 7 Surface Water





Groundwater Monitoring

- Wells and Springs
- Permit will document programs
- Sampling procedures
- Build and optimize
- Corrective Action to Compliance
- Achieve Detection Monitoring